

DSE-831-88

COMMONWEALTH OF VIRGINIA
Department of Air Pollution Control

INTRA-AGENCY MEMORANDUM

TO: Regional Toxics Engineers

FROM: Air Toxics Program Coordinator

SUBJECT: Policy for Formaldehyde Emission Estimates

DATE: December 27, 1988

As you know, the Department has been investigating formaldehyde emission rates from furniture plant veneer press applications. Our investigation was prompted by the furniture industry's inability, during the pilot-program inventory, to provide accurate numbers for formaldehyde (HCHO) emissions from urea-formaldehyde resins. Our initial assumption and the emission estimate currently in use, was that all "free formaldehyde" was emitted. Free formaldehyde was defined, for agency purposes, as the unlinked formaldehyde measured with a bisulfite titration at 25°C. This value was found on Material Safety Data Sheets for most resin formulations. The Department felt that this was probably an over-estimation of actual emissions, but had no hard data on furniture press emissions.

We attempted to obtain hard data on HCHO emissions. Several meetings were held with representatives from the furniture industry and those manufacturers who supply their resins. These meetings began in late 1986 and continued throughout 1987. The EPA was asked for assistance through the Control Technology Center and they provided help and some contractor assistance (Radian Corp.) to compile all existing information. The existing information consisted of testing done at several particleboard facilities which used urea-formaldehyde resins. No existing information was found on furniture veneer applications and no manufacturers of resins were able to provide emission estimates.

For most of 1988, we have attempted to design and fund a testing program to establish emission estimates for furniture veneering operations. Appropriate testing would have to account for many variables such as the percentage of free (excess) HCHO, press time and temperature, amount of resin used per square foot of board and resin formulation additives (scavengers). We hoped to develop a pilot-scale press which could be operated in a flow-controlled enclosure, but were not able to free up the manpower and funding required to conduct such testing. Further investigation of HCHO emissions would require an expenditure of time and money that can not be justified by the DAPC at present.

In lieu of actual test data on furniture presses, we will use the best available data. This data pertains to the manufacturing of particleboard and some assumptions must be made in applying it to the furniture industry.

The important differences between resin application in the particleboard and furniture industries include:

- (1) Press Temperature: Press temperatures in the furniture industry range from 250-325° F., while particleboard presses normally operate at higher temperatures between 315-385° F.
- (2) Press Time: Cycle times for resin curing in the particleboard industry generally range from five to ten minutes with somewhat shorter cycles used in furniture veneer, some as low as one minute.
- (3) Percentage Free HCHO: Resins used in the furniture industry generally fall into two categories specific to percent free (excess) HCHO. Low HCHO resins of approximately 0.5% and a second group of resins with about 5% excess HCHO. The resins used in the tested particleboard facilities ranged from 0.4 to 5.7% free formaldehyde (based on bisulfite titration at 25° C.).

The three operational differences listed above would indicate that, due to higher temperatures, longer cycle times and a somewhat higher percentage of excess HCHO in the particleboard industry, the furniture plant emissions of HCHO would be lower for an equal amount of resin used. If emission factors for the particleboard process were applied to furniture process emissions, it should be a fairly conservative prediction.

A relationship between the percentage of excess HCHO and the emission factor for a particular urea-formaldehyde resin can be described through a linear regression analysis of testing done by Tomas, in 1964¹ (see attached Table A-2). All other variables remaining constant, the emission rate (as a percentage of excess HCHO in the resin) is inversely proportional to the weight percentage of excess HCHO in the resin (as determined through bisulfite titration). Mathematically, it can be described as follows:

$$\log (Y) = (-0.106X) + 1.3$$

where: Y = emission rate as % of excess HCHO in the resin

¹Tomas, Michal, Liberation of Formaldehyde During the Hardening of Urea-Formaldehyde Resins at High Temperatures. Holztechnol. 5, special issue: 89-91, 1964.

X = % excess HCHO in the resin

This relationship was derived from the "B" series testing of Table A-2 at 338° F. The relationship is statistically significant at a 99% degree of certainty. The press temperature of 338° F. is at the very uppermost range used in the furniture industry and adds a degree of safety by over-estimating emissions from an "average" veneer press operation. To simplify the emission factor calculation, I suggest that the urea-formaldehyde resins be divided into three categories as determined by the percentage of free or excess HCHO. The categories would be; (1) less than one percent, (2) greater than or equal to one percent but less than or equal to five percent and (3) greater than five percent. For resins with .1% free HCHO, the emission factor is equal to the calculated factor for 0.5% free HCHO resins, or 18% of the free HCHO. The second category of resins would be assumed to emit 16% of the free HCHO (calculated for X=1 then Y=16). For resins with free HCHO contents greater than 5%, the emissions factor equals 6% of the free HCHO.

% FREE HCHO IN UF RESIN	EMISSION RATE (AS % OF FREE HCHO)
< 1%	18%
. 1% 5%	16%
> 5%	6%

These emission rate estimates are applicable to furniture veneer presses with temperatures less than 340° F. and using urea-formaldehyde resins with free formaldehyde contents between 0.4 - 7.0% (as measured by bisulfite titration at 25° C.).

The emission rate estimate should be applied to all applicable pilot-program sources, as well as future inventories of furniture facilities under the Toxics Program. Any permits which involve veneer presses utilizing urea-formaldehyde resins should use these factors and require testing for HCHO emissions. As test results become available, further refinements of these factors will be done.

If you have any questions, please call me at 225-3634.

Approved by: _____/s/
AED, Technical Operations

date: 12/21/88

Approved by:_____/s/
AED, Regional Operations

date: 12/21/88

_____/s/
Charles E. Holmes

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